E/CONF.39/D/7
26 Sept. 1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item : D. 9. 3

India

SELECTION AND NEW TECHNIQUES FOR ENGINEERING METHODS AND PROCESSINGS

By M. M. VADI,
Industrial Adviser,
Ministry of Commerce and Industry,
Development Wing,
New Delhi

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.

3. Summaries of all papers, as submitted by contributors, will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

4. Papers and summaries will not be available for general distribution in advance of the Conference. They will be published in advance in limited quantities only for the use of delegations of participating governments and of other authorized participants. Post-Conference publication and general distribution of the Conference Proceedings will follow United Nations practices as laid down by the United Nations Publications Board.

D.9.3. Selection and new techniques for engineering methods and processings.

M. M. Vadi
Industrial Adviser
Ministry of Commerce and Industry
Development Wing
NEW DELHI.

1. From the point of view of economic development the Twentieth Century's greatest event is the widespread realisation among individuals and nations that were comparatively poor and backward that they are not permanently destined to be so but it is possible to improve their lot through conscious efforts by creating wealth from the human and material resources at their disposal. Application of technology plays the part of a catalyst in human efforts in the conversion of natural resources into wealth. Through the years a gamut of engineering processes and techniques have been developed from which choices could be made for applications to meet different situations on different scales of production. The choice of a process or technique found best in a set of circumstances may not be a right choice under another environment. The characteristicsof under-developed countries are a low per capita income, lack of technical knowledge, experience or skill, capital and a resistance from a large part of the population to any change in the socio-economic pattern of life. It is of paramount importance, an investigation or study be made before the choice of a process or technique is selected for use or adoption in an under-developed country. More harm could be done to an under-developed country by a wrong choice of technology for application in that country.

2.(a) Factors governing the selection of foundry processes relate not only to the types of metals and alloys melted but also to the shape of the products, the quantity involved as well as the subsequent operations which follow the casting process. The earliest melting processes must have used the charcoal fuel and later changed over to coal and coke. As regards the economy of melting and other considerations these processes had their own limitations such as temperature to which a furnace could be raised or the types of metals which could be melted, depending on the equipment that was available. Melting processes have been considerably modernised keeping in view melting economy and by means of increasing thermal efficiency of the process, apart from obtaining the required temperature. For instance, the old cupola practice for the production of grey iron castings has been modified

xxxxxxxx by using better quality coke, recuperative type of blast, keeping at the same time in mind the necessary alternations required in the designs of the furnace itself, to suit these developments. Similarly in the case of aluminium melting, better melting processes have been developed not only to avoid contamination of metal by the gas and other impurities but also to avoid overheating by means of automatic temperature controlled furnaces. Further in the case of alloy steels involving elements like tungsten etc., induction furnaces have found an un-rivalled position, because of the high temperatures they can attain and the Electro Magnetic Stirring which is so necessary for mixing the heavy and light metals to form the proper alloys.

(b) Considerations of industrial economics and speed have also given rise to modern processes like electric arc melting and the resistance melting. Industrial demands have given rise to vacuum melting applied to magnesium and its alloys. In all melting operations, apart from thermal efficiency, it is the availability of the thermal energy which is most important consideration. The direction of progress has been towards utilising the abundant resources of Solar energy for melting. The development on the castings and forming sides have been no less numerous from the days of primitive sand moulding to the modern days, Moulding was considered for a long time, more as an art than as a technique. Considerable mechanisation has crept into the field and has played its own part in the design of the castings. Bigger castings have been split up into smaller ones and more complicated ones into simpler ones. Hand-operated pin lift machines are still in existance today side by side with pneumatically operated jolt squeeze, roll-over machines which are fast yielding place to semi automatic and fully automatic moulding machines which are capable of bringing down the man-hours on the moulding operations. Similarly on larger castings human efforts have been replaced by sand slingers and pneumatic rammers, which not only ease the process but also give greater uniformity. Apart from sand moulding other casting methods like centrifugal castings, gravity die casting, pressure die casting and shell-moulding processes have been developed each with its own purpose. These processes are more influenced by the type of metal and product involved. For instance grey iron is more easily centrifugally cast while the non-ferrous metals are more easily die cast. As for pressure die casting special low melting alloys of medium strength are developed. A lot of development work has been done with a view to making the casting operations more precise and to minimise the subsequent machine operations. The modern shell moulding processes for small components like gears, are a fine example of this. It will also be interesting to note that roters for small electric motors are pressure die cast with aluminium replacing the general winding process. Considering the loss of metal due to shrinkage on solidification, continuous casting methods have been developed for straight shaped casting.

On the same line, core making pouring, fettling and cleaning operations have undergone extensive developments to suit mass production and to improve the finish. Complicated over baked cores have been replaced by quicker carboh-di-oxide process cores. Hand bruch cleaning of castings has given place to sand blasting and shot blasting operations in automatic and modern machines.

(c) Selection of engineering materials has undergone its own development. Old heavy iron castings are being replaced by lighter aluminium alloy castings as in the case of automobile cylindors and cylinder heads and in certain air craft parts. Metal components have been replaced by non-metallic components as in the case of certain gears and covers where plastics have taken in field.

(d) Developments in forging operations have similarly been influenced by the shape of the product, type of the material though however, many forgings are being replaced by castings due to purely economic considerations. From the simple hammer forge to the modern automatic hydraulic presses, the development has brought in more complicated products as well as much larger sizes. While the forging operations give rise to a dense metal structure it has its own limitation in the versatality of the products. While more complicated components yield themselves better to the casting process the sample components are more easily forged. Both the processes have their own advantages and disadvantages; for instance modular iron cast crank shafts are competing with forged alloy steel counterparts; complicated components like pistons are forged in preference to the castings for particular types. For long straight sections pressure extrusion has a good application especially in the case of non-ferrous metals and plastics.

(e) Side by side with the casting and other forgint techniques the need for better testing methods has also been fulfilled by laboratory developments in the chemical, physical and metallurgical fields. The old chemical analysis procedures have fast been replaced by modern and quick spectroscopic and electronic methods and old filing tests have been abandoned. Modern hardness and tensile testing machines have come into existence. Performance needs of the product have also introduced special testing-operations like surface finish testing, magnetic crack detection etc. etc.

(f) Safety demands in the aircraft industry have introduced the non destructive testing methods like X'ray Radio graphy. Other non destructive testing operations like supersonic tests have saved a lot of machine time by eliminating

defective components before they go into operation.

(g) Side by side with the development of casting and forgings, etc. there was also need for modern machines and machining techniques. With the availability of machines, a new thinking has come into existence with regard to mass production and engineering economics. Ford of United States are the best example. It is wellknown that they were the first to introduce the idea to divide the work in operations. The main purpose for this was to divide the machining operations into different categories keeping in mind different timings instead of doing various number of operations on one and the same machine. This necessitated the development of special machines for different machining operations. The quality of the materials to be machined also influenced the method of machining which has further necessitated the development of different types of machines, fixtures, cutting tools and coolants. Machining originally started with very simple materials like mild steel and cast iron with very oridinary tools, sometimes tempered steels, carbon steels etc. It was very difficult neither to attain the required accuracy, nor the finish. Development in the field of different special machines as well as the tools have made it possible now to answer the demands of accuracy in the modern industrial field. The use of tools like high speed tools, tungsten carbide, tipped tools, industrial diamonds and ceramics tipped tools have not only increased the production rate, the accuracy and the finish also have increased the tools life. Hand in hand, with this development greater care is being taken for the safety and health and comfort for the operators. From the simple lathes to the modern high speed automatics, there are a gamut of intermediate machines e.g. the semi-automatics and automatics. Where smaller quantities and the larger components are involved, simpler and individual operations are implied while smaller components with larger quantities adapt batch production methods. At the same time, larger components involving a number of operations, sometimes from the start to the finish, are machined on fully automatic machines. For example, machining of internal combustion engine blocks are machined on fully automatic machines and the bores are finished on multiple spindle automatic honing machines. Modern developments in machining process in Europe and other industrialised countries have not only helped to reduce the labour but also to increase the rate of production, uniformity and quality of the products. Simple machines have been converted into multiple operation machines by means of magnetic, hydraulic and copying attachments and manually operated machines have been converted into semi-automatic and full automatic machines using electronic systems, limiting the variety of the product and concentrating mass production of single type and individual type of production completely automatic machining lines were developed

in operation. These are mostly suitable for mass production using the minimum labour but the limitations will be that very highly technical skilled maintenance operators will be necessary to keep the installation running. It is needless to mention that such highly automatised installations are not always suitable not only for its poor employment potential but also for the lack of skilled technicians to maintain these. Compromising the production, quantity as well as the quality, semi-automatic machines have been found very suitable for less developed areas.

(h) The selection of finishing operations are governed by various factors e.g. protection from corrosion, exidisation, rustings etc., heat resistance, better running conditions as in the case of pistons in engines, better fitting and also for better appearance. For instance, automobile pistons are tin-coated, lead-coated, graphite coated or anodized as per the requirements of conditions while piston rings are chrome-plated, granodised, oxidised and tinplated. Combinations of one or more process are also in vogue. Whereas for finishing unmachined surface and components, painting is the usual practice, enamelling of metallic components has its own application. Brush painting has become obsolete in industrial finishing history. Modern spray painting on the most scientific lines has come into existence. As for electro-plating, simple operations have been replaced by batch operations and continuous plating process with the new techniques, methods and laboratory equipment, Mechanical polishing is being replaced by electrolytic polishing and buffing.

(i) In the early industrialisation, it was found necessary that the parts being cast or machined should be inspected so that the outcome is of a very high quality. For economy, this inspection has to be done during every stage of production or process of the intermediate product so that unnecessary operations on defective parts could be avoided. In addition to this normally a general inspection is being done at the end of the complete process to ensure that each part meets with the specification laid down by the manufacturers in accordance with the requirements of the consumer. Many methods have been developed on the machine itself to such an extent that the inspection equipments are controlled by the production machine too. In the early stages feeler gauges, whether good or bad, were being used. Later on indicators of different accuracies came into existence. After this, air operated and electrolytic devices with high accuracies and checking speed mainly for fully automatic machines were developed. In many cases, the inspection was developed to such an extent that highly complicated and fully automatic electronic devices had to be used. For instance, photo cells are used not only for checking purposes but also for the safety of the machine operators. Heavy machinery like presses are controlled by photo cells.

(j) In the very early days the parts made for assembly of a particular machine were not suitable for an assembly of another of the same kind. With the increase of production and production systems the need came that many parts of any one machine could well be used for in the assembly of another machine of the same kind - in other words parts of different machines of the same kind could be interchanged. This again made it necessary to develop the so-called fit system which laid down for different fittings exact measuring groups and tolerances. Parts produced in this manner opened the possibility for mass assembly in assembling line as is being done in the automobile, radio and telephone industries. Production of the line assembly system has made the assembly itself so simple that each person is doing a little bit of the job in a faster, better and cleaner way as also the tools and equipments implied in the system of assembly are modernised to suit each stage of assembly. Movements of materials and persons are reduced to a very great extent.

3. In choosing a particular technique or method for employment for production of an article involving the basi engineering process the facilities available is a governing factor . Even before a choice is made, it would be necessary to know the purpose for which the end product is required from the point of view of determining the order of limitations if any in its physical dimension and material specification. It is also necessary to know whether any alternative specification of the materials could be permissible, particularly in view of the substitute that may be made available locally. An other important factor/ is the volume of production for a particular product. A new process or technique, even when a choice is made from the considerations as indicated may have to be given up in place of another on account of higher costs involved. For different processes different raw materials may also be required. All these are further influenced by human skills that are available and ultimately the costs involved.

4. India, relatively speaking, could still be regarded as an under-developed country. It is a large country with a big population. Her needs for the products of the modern industry has been ever growing as in every other country. The country has fortunately considerable natural resources. Having this advantage she decided to industrialise herself and has been proceeding in that direction through the programmes as set out in her successive Five Year Plans. The first two Plans covered a period of 10 years from 1951 to 1960. She is in the third now.

(b) Basic engineering facilities that had been established in India before, largely served the sole purpose of servicing of several plants and equipment of imported origin operating in India , examples of these are the loco shops, automobile service and repair stations, auxiliary engineering shops in power houses, cement, paper and fertiliser factories. The first independent

basic engineering facility that came to be established was for for manufacture of several simple agricultural implements which were replacing some of those made of wood. These facilities, as the scale of operation increased, were gradully improved and modernised for quality control and achieving reduction in costs when competition arose. The first complete machine taken up for manufacture was manually operated pumps. This was followed with power driven pumps, sugar cane crushers including diesel engines. From these early beginnings a wide range of plant and machinery including machine tools have been undertaken for manufacture. The development has also been extended to cover electrical machinery and transport equipment, from bicycles to motor vehicles and locomotives and ships and even air crafts. Progress is also being made in the manufacture of house-hold goods such as sewing machines, radios, refrigerators, telephones etc. All these developments have demanded the need for more iron and steel, power transport and a multitude of other ancilliary products. Even during the processof these developments, the technological processes and techniques have undergone tremendous changes. In the whole field of industrial growth in India, she has taken advantage of the advanced industrial progress where-ever the results anticipated were in keeping with planned programme.

(c) With regard to MACHINE TOOLS, initially the manufacture of these was taken on individual piece basis and in cases the mating parts had to be matched against each other by manual methods to obtain the desired accuracy of the final product. With the development in the manufacturing techniques of machine tools the above process gave place to batch production using jigs and fixtures. This could only be justified by the corresponding rise in demand. A typical case would be the fitting of tail stock quills in the tail stock body on the basis of selective assembly. Later, as technique developed the two could be independently machined and fitted together in assembly with minimum hand work. Similarly scraping of mating parts was adopted when the demand for machine tools did not justify the use of special purpose grinding machines. The latter technique has now replaced scraping. In the manufacture of small tools there has not been any substantial difference in the manufacturing techniques adopted in India to those employed by foreign manufacturers for most of the items. Where foreign countries have developed new processes-the Indian manufacturers are trying to adopt the modern processes. A typical example is that of manufacture of twist drills where there has been a prgressive change in the method of manufacture keeping in line with the Western methods. For instance the flutes of twist drills used to be milled in the initial stages followed by operations like hardening, grinding etc. This method was replaced by a grinding method wherein flutes are straightaway ground on to hardened blanks. Even this process is being superseded by what is called the 'Flute Forging Method'.

(d) The bicycle and sewing machine industries in India have been established for large and small scale production. Modern techniques with installation of latest type machinesas are in vogue in the advanced countries are being used with advantage in the large scale factories. On the other hand the small scale units have adopted conventional methods of manufacture with machinery made in the country or duplicated. The malleable castings were used for hubs and B.B. shells but the use of such castings is now being discarded as a result of the introduction of pressed steel B.B. shell and pressed steel or tubular hubs castings. The widely used process in India is grey iron sand casting for all cast iron parts. Mechanised foundries based on modern principle of production flow with mechanical handling devices are there in India. There are smaller foundries having conventional manually controlled machines for several operations such as mould-making, cone making, iron making and cleaning and finishing. Die casting process in India is being widely used for variety of articles but its use for sewing machine industry is restricted. The question of amortisation of the cost of die casting equipments and dies vis-a-vis the offtake of the die cast parts restricts the use of this process in smaller factories. Recently there have been efforts to introduce powder metallurgical process and investment process in India for small intricate parts like shuttle, bobbin case etc. Aluminium arm and bed in sewing machine are replacing cast iron parts in Europe and America because of the advantage of the former in respect of lightness, better finish and saving of some machining operation. Due to shortage of aluminium all these years and dependence on imports for the equipments this process was not attempted hither to.

(e) In the field of Automobiles, the process and technique in the industrially advanced countries may be said to have reduced the human labour involved. For adoption of such techniques and processes the investment involved in establishing the services is so large, a developing country such as India could illafford and also because the scale of operation does not warrant such a techniques. The Indian Automobile Industry has a larger proportion of general purpose machines than could be found in places where mass production techniques are employed. This picture is continuously changing.

5. One of the crucial problems facing under-developed countries on the threshold of industrialisation is technical-know and this is particularly true of engineering industries, the establishment and operation of which makes large demands on a variety of specialisations and skills. Right from the stage of blue-printing of industrial projects to the selection of sites, development of land, buildings and ancilliary services, choice of raw materials, machinery range and diversity of output and

techniques, training and placement of production operatives and supervision of such personnel, a complex range of technical problems would pose the entrepreneur from day to day. The answer to this challanging task is of course for the country concerned to plan from the very beginning as a part of its national policy for a widespread establishment of facilities for spread of technical education both at the acamemic and practical levels. As this, however, is a time consuming process and as developments in engineering technology particularly in the more advanced countries are proceeding fast, it may be wise for any under-developed country, atleast in the initial stages to borrow technical know-how from the developed countries in any desired field, if it wishes to make rapid progress. The most practical and fruitful form in which such technical know-how can be made available by the developed to the under-developed countries is the conclusion of mutually beneficial private technical collaboration arrangements between well established firms in the former and entrepreneurs in the latter. However, the role of Government to Government technical assistance programme in furthering this objective has also a contribution to make Two outstanding examples of international technical collaboration at the present time in the field are the United Nations Expanded Programme of technical assistance and the technical co-operation scheme of the Colombo Plan. Besides there are bilateral Government to Government technical aid schemes sponsored by the industrially advanced countries like the U.S.A., U.S.S.R., France and West Germany. The types of industrial projects most likely to receive favourable consideration from these foreign technical assistance authorities are those which are designed to further industrial development in under developed countries as catalysts, applied selectively at crucial sectors of the national economy. The Technical assistance is available under these programmes in the shape of both foreign experts and fellowships abroad. This country has benefited substantially by drawing on such international programmes of technical assistance. In the engineering industries, during the last decade, there have been several visits by foreign experts in the field of industrial engineering , tool engineering, foundry and forging technology and metal finishing mostly from U.S.A. and Japan. There were visits by a number of experts in pinpointed fields of specialisation like furnace electrodes, coated and bonded abrasives, machine tools and calibrated steel chains. These experts have through specified periods of in-plant assignment to various industrial units helped to identify and solve on the shop floor a number of technical problems in raising production, improving quality, and lowering costs. Similarly several young engineers from several industrial units in engineering industries were sent abroad during the period under these programmes for acquiring advanced technical know- how.

80 E - Oct. 1962 - 1, 500